CLAIMS

1. A lithographic apparatus comprising:

a level sensor arranged to determine a height of each of a plurality of points on a surface of a substrate, the substrate being provided with at least one die; and

a processor configured to create a first height map based on the determined heights, to calculate a topology based on information of said first height map that corresponds to said at least one die, and to produce a second height map of said surface based on a difference between said topology and said first height map.

2. The lithographic apparatus according to claim 1, wherein the second height map is based on differences between said topology and portions of said first height map that correspond to said at least one die.

3. The lithographic apparatus according to claim 1, wherein said processor is configured to detect, based on said second height map, focus spots on said surface.

4. The lithographic apparatus according to claim 3, wherein said apparatus comprises a reporting system arranged to report at least a detection of focus spots.

5. The lithographic apparatus according to claim 4, wherein said reporting system and said processor are arranged to report detection of different classifications of focus spots.

6. The lithographic apparatus according to claim 1, wherein said topology is an average die topology.

7. The lithographic apparatus according to claim 1, said apparatus further comprising:

a radiation system configured to supply a beam of radiation;

a projection system configured to image an irradiated portion of a mask onto a target portion of the substrate;

a mask holder configured to hold the mask; and

a substrate holder configured to hold the substrate.

8. The lithographic apparatus according to claim 7, said apparatus further comprising:

a first object table configured to move the mask relative to the projection system; and

a second object table configured to move the substrate relative to the projection system.

9. The lithographic apparatus according to claim 1, wherein said processor is arranged to:

produce a smoothed height map based on said second height map;

produce a subtracted height map based on a difference between said smoothed height map and said second height map; and

determine focus spots as being areas in which a residual on said subtracted height map is greater than a threshold.

10. The lithographic apparatus according to claim 9, wherein said processor is arranged to produce a smoothed height map using a moving average principle.

11. The lithographic apparatus according to claim 9, wherein said processor is arranged to determine the threshold based on the subtracted height map.

12. The lithographic apparatus according to claim 9, wherein the threshold is based on a standard deviation of substantially all of the residuals in said subtracted height map.

13. The lithographic apparatus according to claim 12, wherein each residual corresponds to an x, y position.

14. The lithographic apparatus according to claim 9, wherein said processor is arranged to determine a plurality of thresholds based on the subtracted height map.

15. The lithographic apparatus according to claim 9, wherein said processor is arranged to:

produce a feedback height map by removing, from a subtracted height map, determined heights corresponding to dies that overlap with determined focus spots; and

generate a corrected subtracted height map based on the feedback height map, wherein said generating includes:

calculating a corrected average die topology using said feedback height map;

subtracting said corrected average die topology from said feedback height map for dies on said substrate, to produce a corrected second height map of said surface of said substrate;

smoothing said corrected second height map to produce a corrected smoothed height map;

subtracting said corrected smoothed height map from said corrected second height map to produce a corrected subtracted height map; and

determining focus spots as being areas in which a residual on the corrected subtracted height map is greater than a threshold.

16. The lithographic apparatus according to claim 15, wherein said processor is arranged to determine the threshold based on the subtracted height map.

17. The lithographic apparatus according to claim 15, wherein said processor is arranged to produce feedback height maps and to generate corresponding corrected subtracted height maps until a certain accuracy level is reached.

18. The lithographic apparatus according to claim 1, wherein said processor is arranged to subtract from said first height map a data set expressing a global shape of said substrate.

19. The lithographic apparatus according to claim 18, wherein said data set includes a polynomial fit.

20. The lithographic apparatus according to claim 9, wherein said processor is arranged to smooth said second height map by applying a two-dimensional averaging window.

21. The lithographic apparatus according to claim 9, wherein said processor is arranged to smooth said raw height map by calculating an average height AH(x,y) at a point x,y,

wherein said average height AH(x,y) is equal to the sum of all heights $H(x_i,y_i)$ in a window [*(x-a, y+a), (x-a,y-a), (x+a,y+a), (x+a,y-a)*] divided by the number of points x_i,y_i in said window, where *a* is the size of said window.

22. The lithographic apparatus according to claim 1, wherein said second object table is movable between an exposure station and a measurement station, and wherein said apparatus comprises:

a positioning system configured to move said second object table between said exposure station and said measurement station; and

a control unit constructed and arranged to control a position of said second object table, during exposure of said target portion, in accordance with said measured height map, and

wherein said projection system is configured to image said mask portion onto said substrate when the second object table is at the exposure station.

23. A method of manufacturing devices, said method comprising:

determining a height of each of a plurality of points on the surface of a substrate, the substrate being provided with at least one die;

generating a first height map based on the determined heights;

calculating a topology based on information of the first height map that corresponds to said at least one die; and

producing a second height map of said surface, said producing including subtracting said topology from at least a part of said first height map.

24. The method of manufacturing devices according to claim 23, wherein the second height map is based on differences between said topology and portions of said first height map that correspond to said at least one die.

25. The method of manufacturing devices according to claim 23, said method comprising detecting, based on said second height map, focus spots on said surface.

26. The method of manufacturing devices according to claim 25, said method comprising imaging irradiated portions of a mask onto target portions of the substrate having a radiation-sensitive layer.

27. The method of manufacturing devices according to claim 26, wherein said imaging is repeated to expose a plurality of substrates, and wherein said method comprises comparing subtracted height maps of said plurality of substrates to detect correlations in the locations of focus spots.

28. The method of manufacturing devices according to claim 25, said method further comprising reporting at least a detection of focus spots.

29. The method of manufacturing devices according to claim 23, wherein said topology is an average die topology.

30. The method of manufacturing devices according to claim 23, wherein said method comprises:

producing a smoothed height map based on said second height map;

producing a subtracted height map based on a difference between said smoothed height map and said second height map; and

determining focus spots as being areas in which a residual on said subtracted height map is greater than a threshold.

31. The method of manufacturing devices according to claim 30, wherein said producing a smoothed height map includes using a moving average principle.

32. The method of manufacturing devices according to claim 30, wherein said threshold is based on the subtracted height map.

33. The method of manufacturing devices according to claim 30, wherein the threshold is based on a standard deviation of substantially all of the residuals in said subtracted height map.

34. The method of manufacturing devices according to claim 30, wherein said method includes:

producing a feedback height map by removing, from a subtracted height map, determined heights corresponding to dies that overlap with determined focus spots; and

generating a corrected subtracted height map based on the feedback height map, said generating including:

calculating a corrected average die topology using said feedback height map;

subtracting said corrected average die topology from said feedback height map for dies on said substrate, to produce a corrected second height map of said surface of said substrate;

smoothing said corrected second height map to produce a corrected smoothed height map;

subtracting said corrected smoothed height map from said corrected second height map to produce a corrected subtracted height map; and

determining focus spots as being areas in which a residual on the corrected subtracted height map is greater than a threshold.

35. The method of manufacturing devices according to claim 23, wherein said processor is arranged to subtract from said first height map a data set expressing a global shape of said substrate.

36. The method of manufacturing devices according to claim 23, wherein said smoothing said second height map includes applying a two-dimensional averaging window.